PATENT APPLICATION

ASYMMETRIC WIRELESS PROTOCOL COMMUNICATIONS

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BACKGROUND OF THE INVENTION

[0001]   Wireless networks have become increasingly popular, as computers and other devices can be coupled for data communications without requiring wired connections

5   between the network nodes. One set of standards for wireless networks is the IEEE 802.11 standards, but other wireless standards or protocols might be used instead. In the IEEE 802.11 standards, there are at least two widely-used standards, 802.11a and 802.11b, and communication systems and devices might be required to support both standards and/or be required to operate in areas where both are being used. Enhancements to the 802.11

10   standards have been in place, such as the 802.11g standard that allows for OFDM transmissions (802.11a is an OFDM transmission protocol) in the 2.4 GHz band.

[0002]   The 802.11a protocol supports OFDM transmissions in the 5 GHz band for data rates of 6 to 54 million bits per second ("Mbps"). The 802.11b protocol supports DSSS transmissions in the 2.4 GHz band for data rates of 1, 2, 5.5 and 11 Mbps. The 802.11g

15   protocol mixes OFDM and DSSS protocols in the 2.4 GHz band for data rates of 1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48 and 54 Mbps. Data transmissions are well known for these protocols, so they need not be set forth herein. They are described, for example, in ANSI/IEEE Std 802.11, 1999 Edition; IEEE Std 802.11b, 1999; IEEE Std 802.11a, 1999/Amd 1:2000(E). Those references are incorporated by reference herein for all purposes.

20   [0003]   The 802.11b protocol can be supported by a station with a lower power than the full range of the 802.11g protocol. One reason for this is that the 1 to 11 Mbps transmissions can be at a lower signal-to-noise ratio (SNR) than the 12 to 54 Mbps transmissions. Another reason is that demodulation is simpler for DSSS than OFDM. Thus, where power limitations exist at a station, 802.11b might be used instead of 802.11g. Where a station is not

25   power-limited and higher data rates are needed, the 802.11g protocol might be preferred, as data rates can be as high as 54 Mbps.

[0004]   It would be desirable to overcome the shortcomings of the prior art described above.

BRIEF SUMMARY OF THE INVENTION

[0005]   In one embodiment of a wireless network, data transmitted from one of an access

30   point station and a client station to the other of the client station and the access point station is

transmitted using the 802.11b protocol while data transmitted in the other direction is transmitted using the 802.11g protocol.

[0006]   In some embodiments, data is sent with one protocol and acknowledgements are returned in the other protocol. Thus, the client station might send data in one protocol of

5   802.11b or 802.11g and the access point station acknowledges the data in the other protocol. Likewise, the access point station can send data in one protocol and receive acknowledgements in the other protocol.

[0007]   A further understanding of the nature and the advantages of the inventions disclosed herein may be realized by reference to the remaining portions of the specification and the

10   attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]   Fig. 1 is a block diagram of a simple wireless network that might use the present invention.

[0009]   Fig. 2 is a block diagram illustrating the coupling between one device and one

15   network connection of the wireless network shown in Fig. 1.

[0010]   Fig. 3 is a block diagram of a receive section of station hardware as might be used in hardware illustrated in Fig. 2.

[0011]   Fig. 4 is a block diagram illustrating data communication among two client devices.

[0012]   Fig. 5 is a block diagram illustrating data communication between an access point

20   and a network interface card of a client device.

DETAILED DESCRIPTION OF THE INVENTION

[0013]   Fig. 1 illustrates a simple wireless network that might use the present invention. As shown in Fig. 1, a wireless network 10 comprises a plurality of stations 12 wherein each station 12 is capable of communicating with at least one other station 12 of wireless network

25   10. In specific implementations, wireless network 10 is a local area wireless network, as might be used within a building, campus, vehicle or similar environments.

[0014]   In a specific embodiment, wireless network 10 is designed to be compliant with one or more of the IEEE 802.11 standards. However, it should be understood that other standards and nonstandard networks might be substituted therefore to solve problems similar to those

30   solved in the 802.11 environment.

[0015]   As shown, some of the stations are coupled to client devices 14, while other stations are coupled to wired network interfaces 16. For example, station 12(1) is coupled to client device 14(1), while station 12(3) is coupled to a wired network interface 16. Fig. 1 is intended to be a simplified and generalized diagram of a wireless network. Interfering signal generators are not shown, but are assumed to be present. More generally, wired network interfaces 16 might be instead replaced with other types of distribution systems as the invention is not limited to a particular interface.

[0016]   Examples of client devices 14 include laptops, personal digital assistants (PDAs), or any other portable or semi-portable electronic device needing to communicate with other devices, or a stationary electronic device needing to communicate with other devices where a wired connection to a network or the other devices is not available or easily provided. Wired network interfaces 16 couple their respective stations to a network. Examples of such networks include the Internet, a local area network (LAN) or a public or private connection to a TCP/IP packet network or other packet network or networks.

[0017]   In a typical operation, a plurality of client devices 14 are outfitted with circuitry and/or software that implements a station 12 functionality and one or more network access points are provided in wireless network 10 to provide access between such a client device and the network to which a wired network interface (or other distribution system) is coupled. A station coupled to a wired network interface or other distribution system is referred to as an "access point". Just one example of the uses of such a system is to connect computers within a building to a network without requiring network wires to be run to each computer. In that example, the building would be outfitted with stationary access points coupled to the network that are within wireless communication range of wireless network cards in each of the computers coupled to the network.

[0018]   Fig. 2 shows in more detail the coupling between one client device and one distribution system. As shown there, client device 14 is coupled to a device I/O section of client station hardware 20. Client station hardware 20 includes a transmit section and a receive section, each coupled to the device I/O section. The transmit section transmits a signal through a wireless channel 21 to a receive section of access point station hardware 22. That receive section is coupled to a network I/O section, thus providing a data communication path from client device 14 to a distribution system 28. A path from distribution system 28 to client device 14 is also provided via the network I/O section of

3

access point station hardware 22, a transmit section of access point station hardware 22, a

receive section of client station hardware 20 and the device I/O section of client station

hardware 20. The characteristics of wireless channel 21 depend on many factors, such as the

location of client station hardware 20 and access point station hardware 22 as well as

5   intervening objects, such as walls, buildings and natural obstructions, as well as influences by

other devices and transmitters and receivers and signal-reflecting surfaces.

[0019]   Typically, client station hardware 20 can be integrated in with client device 14. For

example, where client device 14 is a laptop computer, client station hardware 20 might be an

add-on PCMCIA card that is inserted into the laptop's PCMCIA slot. Access point station

10   hardware 22 might be implemented as part of a wired network interface device that is just

used to couple a wired network to a wireless network. Notwithstanding the typical

implementation, it should be understood that nothing here prevents the diagram of Fig. 2

from being entirely symmetrical, i.e., wherein client station hardware 20 and access point

station hardware 22 are nearly identical instances of hardware devices, however in many

15   cases, a station that is an access point will be fixed and the station that is not an access point

is in a portable or mobile device where power usage, cost, weight and/or size are

considerations. Furthermore, communication is not limited to being between a client and an

access point, as two clients can communicate and two access points can communicate.

[0020]   What follows is a detailed description of a receive section. Fig. 3 illustrates

20   components of a receive section 30. Receive section 30 receives one or more signals over the

wireless channel via antennas 32, which are initially processed by RF section 34. RF section

34 might, for example, process the signals to form baseband signals to form digital signal

streams. As shown, receive section 30 also might include FIR(s) 35 and various subsections

40, 42, 44 for processing 802.11a, 802.11b and 802.11 extended signals, respectively.

25   Further details of elements of receive section 30 not more fully described herein are shown in

U.S. Patent No. _____ (U.S. Patent Application 10/068,360, filed on February 5, 2002

on behalf of Steele et al. and entitled "Multi-Antenna Wireless Receiver Chain With Vector

Decoding" and hereinafter "Steele"), which is incorporated by reference herein for all

purposes. It should be understood that the present invention is not limited to the particular

30   receiver implementations shown here or there.

[0021]   In the asymmetric modes described herein, transmission from a client station (e.g., a

mobile and/or portable station) to an access point, in one direction is one protocol and in

4

another direction is another protocol taking into account asymmetric bandwidth needs in each
direction and/or taking into account asymmetric power, cost, weight and/or size limitations.

[0022]   In a specific example, a client station sends data to an access point using the
802.11b protocol, while the access point sends data to the client station using the 802.11g
protocol. Where most of the data flowing between the client station and the access point is
flowing downstream from the access point to the client station, the network capacity is
effectively the capacity of the 802.11g protocol with the range of the 802.11b protocol. One
reason for this is because 802.11b works at lower SNR's due to the use of DSSS.

[0023]   The 802.11g standard is a modification of the previous 802.11b standard that allows
for additional, higher data rates. The 802.11b rates are 1, 2, 5.5 and 11 Mbps (four data
rates), while the 802.11g rates are 1, 2, 5.5, 6, 9, 11, 12, 18, 22, 24, 33, 36, 48 and 54 Mbps
(eleven data rates). For ease of reference, the 1, 2, 5.5 and 11 Mbps data rates are referred to
herein as the "11b" rates and the 6, 9, 12, 18, 22, 24, 33, 36, 48 and 54 Mbps data rates are
referred to herein as the "OFDM" rates. Note that where the OFDM rates can be used, higher
data throughput is possible. However, under some less-than favorable conditions, an 11b rate
is preferred over an OFDM rate as, for example, the data can be successfully transmitted
using the 11b rates where the signal-to-noise ratios (SNRs) are low, as the required SNRs for
11b rates are lower than for higher rate OFDM rates.

[0024]   This asymmetry has significant implications where one of the receivers is more
sensitive than the other. For example, if two stations are not near each other, or there are
other reasons why significant noise is introduced, a more sensitive receiver can receive at a
higher data rate while transmitting to the less sensitive receiver at a lower data rate. The
receiver might be more sensitive because it uses innovations such as those described in Steele
and U.S. Patent No. _____ (U.S. Patent Application 10/068,571, filed on February 5,
2002 on behalf of van Nee et al. and entitled "System for Soft Symbol Decoding with MIMO
Log-Map Detection" and hereinafter "van Nee"), which is incorporated by reference herein
for all purposes.

[0025]   Where two sensitive receivers are used, they can both handle low SNRs. However,
where one receiver, such as the receiver in a client device is more sensitive than the receiver
in an access point, the access point can transmit using OFDM data rates while the client
device transmits using 11b rates. This is advantageous especially where the data flow is
greater towards the client device than away from the client device - a typical scenario where

the client device is consuming information from a remote server via the wireless network. Since access points are typically stationary devices and client devices are typically mobile or portable devices, device size, power consumption, computing power, antenna positioning and reliability would be expected to be more constrained in a client device relative to an access

5   point, which could lead to situations wherein a client device with a sensitive receiver would be in range for receiving OFDM transmissions while the less sensitive receiver at the other end might be out of range for receiving OFDM transmissions.

[0026] The advantages also apply when the access point has a sensitive receiver, for example, one designed by Airgo Networks, Inc. In such cases, the access point station

10   transmits using an 11b data rate, to be received by a less sensitive network interface card (NIC) supporting a client device, rather than an OFDM data rate, but receives data from the NIC at an OFDM data rate. Acknowledgements ("ACKs") might be transmitted in a similar manner, as shown in Fig. 4. As shown there, a first station device 60 transmits to a second station device 62 using an 11b data rate while receiving ACKs at an OFDM data rate. When

15   the second station device 62 transmits data, it does so at an OFDM data rate while receiving ACKs at an 11b data rate. In this example, first station device 60 can be either an access point station or a client device station and second station device 62 can also be either an access point station or a client device station - nothing here prevents two client devices or two access points from using these techniques to communicate among themselves.

20   [0027] Where two sensitive receivers are involved, such as two Airgo Networks devices, an asymmetry might still exist, such as a power constraint asymmetry. Assume, for example, that a sensitive access point is deployed and communications with a sensitive NIC and that the access point has a steady source of power, whereas the NIC is preferably a low-power device. This is desirable where the NIC draws power from a battery, such as the battery of a

25   laptop, a cellular telephone, a PDA, or the like, where the battery must be carried or ported (so the size, and therefore the capacity of the battery is constrained). In such cases, 11b and OFDM rates might be used as indicated in Fig. 5.

[0028] The NIC-to-AP link budget is often less than the AP-to-NIC link budget due to the lower transmit power available for the NIC to spend, however that need not always be the

30   case. Even where neither side is constrained in its use of transmit power, there are asymmetries. Some of these are due to, for example, variable transmit power, variable noise

6

figure values for receiving radios and variable numbers of antennas used to increase receiver sensitivity.

[0029]   Another source of asymmetry is that, for a given power amplifier, packets of 11b signals can be sent with more transmit power because they require less linearity than OFDM signals and thus can drive the power amplifier further in its dynamic range.

[0030]   As described above, a sensitive access point and a less sensitive client device (such as an access point designed by Airgo and a client device using a station of another design), can benefit from the asymmetric transmissions described herein. Also, a sensitive access point with a sensitive client device with power constraints also benefits. Other cases might also benefit. For example, one station with high available transmit power and low receiver sensitivity (typically an access point, but not required) and another station (typically a client device station, but not required) with low available transmit power and high receiver sensitivity would also benefit from the asymmetric transmissions described herein. One situation where this is likely to be a common problem is where the client device is a personal digital assistant ("PDA"), which has very little transmit power available.

[0031]   The above description is illustrative and not restrictive. Many variations of the invention will become apparent to those of skill in the art upon review of this disclosure. The scope of the invention should, therefore, be determined not with reference to the above description, but instead should be determined with reference to the appended claims along with their full scope of equivalents.